

REMARKS

Claims 74-83 are pending in this application. Claim 75 has been amended to clarify that the upper surface of the copper layer that is implanted with titanium "has a thickness of about 50 Angstroms to about 200 Angstroms." No new matter has been introduced. Applicant acknowledges with appreciation the allowance of claims 79-83.

The drawings stand objected to "as failing to comply with 37 CFR § 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: element 32 (see page 13, line 3)." (Office Action at 2). Applicant submits that the specification has been amended to clarify that the via formed within layers 28 and 30 is labeled as element 33. Applicant also notes that FIGS. 6 and 9-12 have been amended to illustrate element 33.

Claim 75 stands rejected under 35 U.S.C. § 112, second paragraph, as "[i]t is not clear how 'said copper layer has a thickness of about 50 Angstroms to about 200 Angstroms' when in parent claim 74, the copper layer is stated to have 'a thickness of about 500 Angstroms to about 20,000 Angstroms.'" (Office Action at 3). Applicant notes that claim 75 has been amended to recite that the upper surface of the copper layer that is implanted with titanium "has a thickness of about 50 Angstroms to about 200 Angstroms." Applicant submits that all pending claims are now in full compliance with 35 U.S.C. § 112.

Claims 74, 77 and 78 stand rejected under 35 U.S.C. § 102(e) as being anticipated by Braeckelmann et al. (U.S. Patent No. 6,218,302) ("Braeckelmann"). This rejection is respectfully traversed.

The claimed invention relates to a copper bond pad for a semiconductor device. As such, independent claim 74 recites a "copper bond pad" comprising *inter*

alia “a dielectric layer formed over a substrate,” “a barrier layer formed over said dielectric layer” and “a copper layer formed over said barrier layer, said copper layer having an upper surface implanted with titanium, said copper layer having a thickness of about 500 Angstroms to about 20,000 Angstroms.” Independent claim 74 also recites “an insulating layer over said copper layer.”

Braeckelmann relates to an “interconnect (60) . . . formed overlying a substrate (10).” (Abstract). According to one embodiment of Braeckelmann, “an adhesion/barrier layer (81), a copper-alloy seed layer (42), and a copper film (43) are deposited overlying the substrate (10), and the substrate (10) is annealed.” (Abstract). Braeckelmann also teaches that, “[i]n an alternate embodiment, a copper film is deposited over the substrate, and the copper film is annealed. In yet another embodiment, an adhesion/barrier layer (81), a seed layer (82), a conductive film (83), and a copper-alloy capping film (84) are deposited over the substrate (10) to form an interconnect (92).” (Abstract).

The subject matter of claims 74, 77 and 78 is not anticipated by Braeckelmann. Braeckelmann does not disclose, teach or suggest a “copper bond pad” comprising “a dielectric layer,” “a barrier layer formed over said dielectric layer” and “a copper layer formed over said barrier layer, said copper layer having an upper surface implanted with titanium, said copper layer having a thickness of about 500 Angstroms to about 20,000 Angstroms,” as independent claim 74 recites. Braeckelmann teaches that barrier layer 122 is formed over the dielectric layer 110, and that conductive layer 124 is formed over the barrier layer 122. (Col. 3, lines 8-23; Fig. 11). However, Braeckelmann does not disclose that conductive layer 124, which would arguably correspond to the “copper layer” of the claimed invention, has “an upper surface implanted with titanium,” as independent claim 74 recites. In addition, Braeckelmann is silent about the conductive layer 124, which would arguably correspond to the “copper layer” of the claimed

invention, having "a thickness of about 500 Angstroms to about 20,000 Angstroms," as independent claim 74 recites. For at least these reasons, Braeckelmann fails to anticipate the subject matter of claims 74, 77 and 78, and withdrawal of the rejection of these claims is respectfully requested.

Claim 75 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Braeckelmann in view of Werkhoven et al (U.S. Patent No. 6,703,708) ("Werkhoven"). This rejection is respectfully traversed.

Werkhoven relates to thin films "formed by atomic layer deposition, whereby the composition of the film can be varied from monolayer to monolayer during cycles including alternating pulses of self-limiting chemistries." (Abstract). According to Werkhoven, "varying amounts of impurity sources are introduced during the cyclical process" so that "[a] graded gate dielectric is thereby provided, even for extremely thin layers." (Abstract). In this manner, "[t]he gate dielectric as thin as 2 nm can be varied from pure silicon oxide to oxynitride to silicon nitride." (Abstract).

Applicant notes that the subject matter of claim 75 would not have been obvious over Braeckelmann and Werkhoven, whether considered alone or in combination. Indeed, the Office Action fails to establish a *prima facie* case of obviousness. To establish a *prima facie* case of obviousness, three requirements must be met: (1) some suggestion or motivation, either in the references themselves or in the knowledge of a person of ordinary skill in the art, to modify the reference or combine reference teachings; (2) a reasonable expectation of success; and (3) the prior art reference (or references when combined) must teach or suggest all the claim limitations. More importantly, the teaching or suggestion to make the claimed combination and the reasonable expectation for success must both be found in the prior art and not based on Applicants' disclosure. See, e.g., In re Royka, 490 F.2d 981 (CCPA 1974).

In the present case, Braeckelmann and Werkhoven, considered alone or in combination, fail to disclose, teach or suggest all limitations of independent claim 74 (on which amended dependent claim 75 depends). As noted above, Braeckelmann fails to disclose, teach or suggest "a copper layer . . . having *an upper surface implanted with titanium*," as independent claim 74 recites. In addition, Werkhoven is silent about a "copper bond pad," much less about a "copper bond pad" having "a dielectric layer," "a barrier layer formed over said dielectric layer" and "a copper layer formed over said barrier layer, said copper layer having *an upper surface implanted with titanium*, said copper layer having a thickness of about 500 Angstroms to about 20,000 Angstroms," as independent claim 74 recites (emphasis added). Werkhoven relates to graded thin films formed by atomic layer deposition, and not to copper bond pads, much less to copper bonds pads having characteristics and structures such as the ones of the claimed invention. For at least the reasons above, the subject matter of claim 75 would not have been obvious over Braeckelmann in view of Werkhoven, and withdrawal of the rejection of this claim is respectfully requested.


Claim 76 stands rejected under 35 U.S.C. § 103(a) as being unpatentable over Braeckelmann in view of Dubin et al (U.S. Patent No. 5,891,513) ("Dubin"). This rejection is respectfully traversed.

Dubin relates to a method of utilizing electroless copper deposition to form interconnects. Dubin teaches that "[o]nce a via or a trench is formed in a dielectric layer, a titanium nitride (TiN) or tantalum (Ta) barrier layer is blanket deposited" so that "a contact displacement technique is used to form a thin activation seed layer of copper on the barrier layer." (Abstract). Dubin also teaches that "[a]n electroless deposition technique is then used to auto-catalytically deposit copper on the activated barrier layer." (Abstract).

The subject matter of claim 76 would not have been obvious over Braeckelmann and Dubin, whether considered alone or in combination. Again, the Office Action fails to establish a *prima facie* case of obviousness. Neither Braeckelmann nor Dubin, alone or in combination, discloses, teaches or suggests all limitations of independent claim 74. As noted above, Braeckelmann is silent about "a copper layer . . . having an upper surface implanted with titanium, said copper layer having a thickness of about 500 Angstroms to about 20,000 Angstroms," as independent claim 74 recites (emphasis added). Similarly, Dubin fails to disclose, teach or suggest a "copper bond pad," much less a "copper bond pad" comprising "a dielectric layer," "a barrier layer formed over said dielectric layer" and "a copper layer . . . having an upper surface implanted with titanium, said copper layer having a thickness of about 500 Angstroms to about 20,000 Angstroms," as independent claim 74 recites. For at least these reasons, the Office Action fails to establish a *prima facie* case of obviousness, and withdrawal of the rejection of claim 76 is respectfully requested.

Allowance of the application is solicited.

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AMENDMENTS TO THE DRAWINGS

A proposed drawing amendment and replacement sheets are attached, in which FIGS. 6 and 9-12 have been amended to depict via 33.